

## WHAT IS CLAIMED IS:

- 1           1.    A method for determining a germanium concentration of a  
2   silicon germanium film, said method comprising the steps of:  
3           performing a thermal oxidation procedure on said silicon  
4   germanium film to create a layer of thermal oxide over said silicon  
5   germanium film;  
6           measuring a thickness of said layer of thermal oxide;  
7           providing a correlation that relates a thickness of a layer of  
8   thermal oxide created over a silicon germanium film to a germanium  
9   concentration of said silicon germanium film;  
10          determining said germanium concentration of said silicon  
11   germanium film by identifying a germanium concentration that  
12   corresponds to said measured thickness of said layer of thermal  
13   oxide in accordance with said correlation.
- 1           2.    The method as set forth in Claim 1 wherein said step of  
2   measuring a thickness of said layer of thermal oxide comprises  
3   measuring said thickness of said layer of thermal oxide in real  
4   time using one of: an interferometer, an ellipsometer, and a  
5   spectroscopic ellipsometer.

1           3.    The method as set forth in Claim 2 further comprising the  
2    step of:

3           performing in real time said step of determining said  
4    germanium concentration of said silicon germanium film by  
5    identifying a germanium concentration that corresponds to said  
6    measured thickness of said layer of thermal oxide in accordance  
7    with said correlation.

1           4.    The method as set forth in Claim 1 wherein said  
2    correlation that relates a thickness of a layer of thermal oxide  
3    created over a silicon germanium film to a germanium concentration  
4    of said silicon germanium film is an approximately linear  
5    correlation.

1           5.    The method as set forth in Claim 4 wherein said  
2    approximately linear correlation is described by:

3           Oxide Thickness (Å) = 45.55035 + 2.2670656 Ge%

4           where said term Oxide Thickness is in units of Ångstroms; and

5           where said term Ge% represents a germanium concentration in a  
6    silicon germanium film in terms of germanium percentage.

1        6.    The method as set forth in Claim 4 wherein said  
2    approximately linear correlation is described by:

$$3 \quad \text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

4        where said term Relative Oxidation Rate represents a ratio of  
5    a thickness of thermal oxide on a silicon germanium film to a  
6    thickness of thermal oxide on a silicon wafer without a silicon  
7    germanium film; and

8        where said term Ge% represents a germanium concentration in a  
9    silicon germanium film in terms of germanium percentage.

1        7.    The method as set forth in Claim 4 wherein said  
2    approximately linear correlation is described by:

$$3 \quad \text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

4        where said term Relative Oxidation Rate represents a ratio of  
5    a thickness of thermal oxide on a silicon germanium film to a  
6    thickness of thermal oxide on a silicon wafer without a silicon  
7    germanium film; and

8        where said term Ge% represents a germanium concentration in a  
9    silicon germanium film in terms of germanium percentage.

1        8.    The method as set forth in Claim 2 further comprising the  
2    step of:

3        measuring said thickness of said layer of thermal oxide in  
4    real time by making a plurality of thickness measurements of said  
5    thickness of said layer of thermal oxide in real time using  
6    one of: an interferometer, an ellipsometer, and a spectroscopic  
7    ellipsometer.

1        9.    A method for determining a correlation between a  
2    germanium concentration of a silicon germanium film and a  
3    thickness of a layer of thermal oxide created over said  
4    silicon germanium film, said method comprising the steps of:

5        creating a plurality of silicon germanium films in which each  
6    silicon germanium film has a different germanium concentration;

7        creating a layer of thermal oxide over each of said plurality  
8    of silicon germanium films;

9        measuring a thickness of each of said layers of thermal  
10   oxide; and

11       correlating said thickness of each of said layers of thermal  
12   oxide with a corresponding value of germanium concentration.

1       10.   The method as set forth in Claim 9 wherein said  
2    correlation between a germanium concentration of a silicon  
3    germanium film and a thickness of a layer of thermal oxide created  
4    over said silicon germanium film is an approximately linear  
5    correlation.

1        11. The method as set forth in Claim 10 wherein said  
2 approximately linear correlation is described by:

3        
$$\text{Oxide Thickness (\AA)} = 45.55035 + 2.2670656 \text{ Ge\%}$$

4        where the oxide thickness is in units of Angstroms and the  
5 term Ge% represents a germanium concentration in a silicon  
6 germanium film in terms of germanium percentage.

1        12. The method as set forth in Claim 10 wherein said  
2 approximately linear correlation is described by:

3        
$$\text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

4        where said term Relative Oxidation Rate represents a ratio of  
5 a thickness of thermal oxide on a silicon germanium film to a  
6 thickness of thermal oxide on a silicon wafer without a silicon  
7 germanium film; and

8        where said term Ge% represents a germanium concentration in a  
9 silicon germanium film in terms of germanium percentage.

1        13. The method as set forth in Claim 4 wherein said  
2 approximately linear correlation is described by:

3        
$$\text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

4        where said term Relative Oxidation Rate represents a ratio of  
5 a thickness of thermal oxide on a silicon germanium film to a  
6 thickness of thermal oxide on a silicon wafer without a silicon  
7 germanium film; and

8        where said term Ge% represents a germanium concentration in a  
9 silicon germanium film in terms of germanium percentage.

1        14. A method for determining a germanium concentration of a  
2 silicon germanium film, said method comprising the steps of:

3        providing a silicon substrate layer;

4        depositing germanium on said silicon substrate layer to form a  
5 silicon germanium film;

6        performing a thermal oxidation procedure on said silicon  
7 germanium film to create a layer of thermal oxide over said silicon  
8 germanium film;

9        measuring a thickness of said layer of thermal oxide in real  
10 time;

11       providing a correlation that relates a thickness of a layer of  
12 thermal oxide created over a silicon germanium film to a germanium  
13 concentration of said silicon germanium film;

14       determining said germanium concentration of said silicon  
15 germanium film in real time by identifying a germanium  
16 concentration that corresponds to said measured thickness of said  
17 layer of thermal oxide in accordance with said correlation.

1        15. The method as set forth in Claim 14 wherein said thermal  
2 oxidation procedure is one of: a rapid thermal oxidation procedure  
3 and a furnace oxidation procedure.



1        16. The method as set forth in Claim 14 wherein said step of  
2 measuring a thickness of said layer of thermal oxide in real time  
3 comprises measuring said thickness of said layer of thermal  
4 oxide within a time period of approximately five minutes using  
5 one of: an interferometer, an ellipsometer, and a spectroscopic  
6 ellipsometer.

1        17. The method as set forth in Claim 14 wherein said step of  
2 providing a correlation that relates a thickness of a layer of  
3 thermal oxide created over a silicon germanium film to a germanium  
4 concentration of said silicon germanium film comprises the step of:

5        providing an approximately linear correlation described by:

6        Oxide Thickness ( $\text{\AA}$ ) = 45.55035 + 2.2670656 Ge%

7        where the oxide thickness is in units of Angstroms and the  
8 term Ge% represents a germanium concentration in a silicon  
9 germanium film in terms of germanium percentage.

18. The method as set forth in Claim 14 wherein said step of providing a correlation that relates a thickness of a layer of thermal oxide created over a silicon germanium film to a germanium concentration of said silicon germanium film comprises the step of:

providing an approximately linear correlation described by:

$$\text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

where said term Relative Oxidation Rate represents a ratio of a thickness of thermal oxide on a silicon germanium film to a thickness of thermal oxide on a silicon wafer without a silicon germanium film; and

where said term Ge% represents a germanium concentration in a silicon germanium film in terms of germanium percentage.

19. The method as set forth in Claim 14 wherein said step of providing a correlation that relates a thickness of a layer of thermal oxide created over a silicon germanium film to a germanium concentration of said silicon germanium film comprises the step of:

providing an approximately linear correlation described by:

$$\text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

where said term Relative Oxidation Rate represents a ratio of a thickness of thermal oxide on a silicon germanium film to a thickness of thermal oxide on a silicon wafer without a silicon germanium film; and

11           where said term Ge% represents a germanium concentration in a  
12 silicon germanium film in terms of germanium percentage.

1           20. The method as set forth in Claim 14 wherein said step of  
2 depositing germanium on said silicon substrate layer to form a  
3 silicon germanium film comprises the step of:

4           exposing said silicon substrate layer to a gas comprising  
5 silane gas and germane gas in a hydrogen gas carrier.